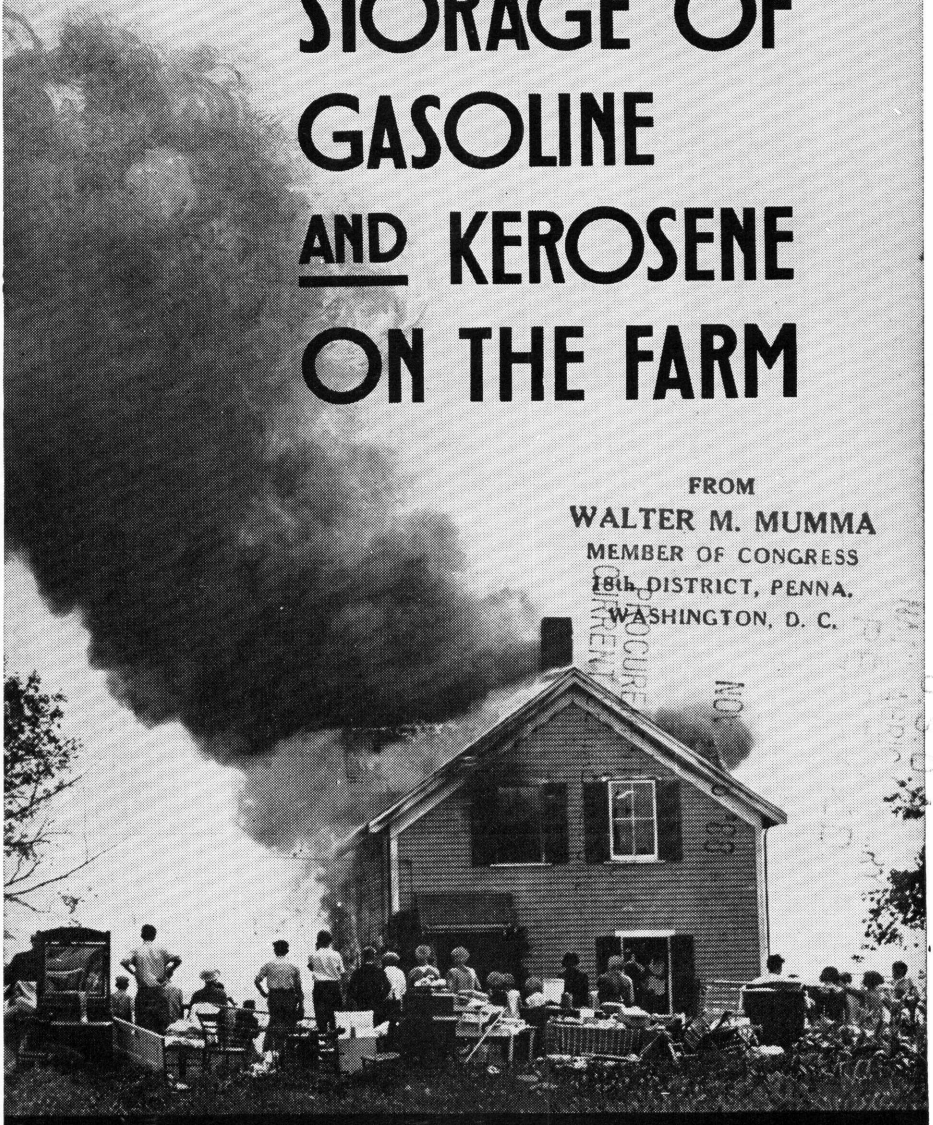
SAFE USE AND STORAGE OF GASOLINE AND KEROSENE ON THE FARM



FROM
WALTER M. MUMMA
MEMBER OF CONGRESS
18th DISTRICT, PENNA.
WASHINGTON, D. C.

FARMERS' BULLETIN NO. 1678
U.S. DEPARTMENT OF AGRICULTURE

CARELESSNESS in using and storing gasoline, kerosene, and other petroleum products causes an annual loss of some 500 lives and an average fire loss of more than $5,000,000 on farms of the United States.

Gasoline and kerosene, as well as other flammable liquids, are always potentially dangerous. Lives and property may be reasonably safeguarded against this fire and explosion hazard, however, by the proper storage and the careful handling and use of these liquids. This bulletin points out the most common hazards and the precautions that should be observed. It also gives information on extinguishing gasoline and kerosene fires.

The United States Department of Agriculture, in an effort to reduce the extensive loss of both life and property as the result of fires on farms, is cooperating with the National Fire Protection Association, with executive offices at 60 Batterymarch Street, Boston, Mass., and other organizations and associations interested in fire prevention.

Washington, D. C.

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SAFE USE AND STORAGE OF GASOLINE AND KEROSENE ON THE FARM

Issued originally by the BUREAUS OF CHEMISTRY AND SOILS, of AGRICULTURAL ENGINEERING, and of AGRICULTURAL ECONOMICS, in cooperation with the NATIONAL FIRE PROTECTION ASSOCIATION;[1] revised by the BUREAUS OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING and of AGRICULTURAL ECONOMICS, in cooperation with the NATIONAL FIRE PROTECTION ASSOCIATION[2]

Contents

FARM FIRES FROM PETROLEUM AND ITS PRODUCTS

GASOLINE, KEROSENE, and other petroleum products are among the principal causes of loss of life by fire on farms and rank sixth among the causes of property loss in farm fires.[3] It is estimated that more than 500 lives are lost annually in farm fires caused by the careless use and storage of gasoline and kerosene and other petroleum products; that more than 1,000 men, women, and children suffer serious burns from this cause; and that more than $5,000,000 worth of farm property is destroyed.

While gasoline and kerosene, as well as other flammable liquids, are always potentially dangerous, lives and property may be reasonably safeguarded against this fire and explosion hazard by the proper storage and the careful handling and use of these liquids.

[1] This bulletin was prepared originally by Harry E. Roethe, senior engineer, of the Chemical Engineering Research Division, Bureau of Chemistry and Soils, chairman of the subcommittee of the Farm Fire Protection Committee on the handling and storage of gasoline and kerosene. The other members of this subcommittee were Clarence Goldsmith, of the National Board of Fire Underwriters, and George F. Lewis, formerly deputy fire marshal of the Province of Ontario.

[2] Wallace Ashby, Bureau of Plant Industry, Soils, and Agricultural Engineering, and Victor N. Valgren, Bureau of Agricultural Economics, are representatives of this Department on the Farm Fire Protection Committee of the National Fire Protection Association, which assisted in carrying on investigations and in supplying valuable data for the revision of this bulletin. The committee membership includes representatives of interested agencies in the United States and Canada. The present revised text was recommended by the National Fire Protection Association Committee on Farm Fire Protection by action at a meeting held on December 11, 1944.

[3] According to estimates by the National Fire Protection Association.

FLAMMABILITY OF GASOLINE AND KEROSENE

All grades of gasoline are highly flammable and are dangerous unless properly handled. The octane ratings of gasoline, or whether or not it is "high test," do not have any important bearing on fire and explosion hazards. In some cases high-octane gasoline may actually be less volatile than ordinary gasoline, but there is not sufficient distinction in hazards to call for different precautions. Motor gasoline usually has lead compounds added to improve the octane rating or antiknock qualities. These lead compounds have no effect upon the fire and explosion hazard but are poisonous, making it dangerous to use leaded gasoline in any way in which persons may be directly exposed to the liquid. The danger of poisoning from leaded gasoline gives added emphasis to the importance of handling gasoline only in closed containers.

Violent explosions may result from the improper use of gasoline, but it is always the vapor mixed with air that is explosive—not the liquid. Gasoline cannot explode in a closed container with no air present, except that it may expand with heat and a gasoline tank may be ruptured from internal pressure if no vent is provided.

Gasoline vapor is heavier than air; consequently, it will float along near the ground, like an invisible stream, for considerable distances. In a lean mixture (a little less than 2 percent) 5 gallons of gasoline will produce 8,000 cubic feet of burnable or mildly explosive gas (gas-air mixture), or enough to fill a room having the dimensions 20 by 40 by 10 feet.

As with other gases and vapors, before an explosion of gasoline vapor can occur a definite proportion of air and gasoline vapor must be present. In 100 parts by volume of air and gasoline, an explosion will not take place if there is less than 1.4 or more than 6 parts of gasoline vapor. This range of explosibility is narrow, as compared with that of many other mixtures of combustible gases and air; nevertheless in the lower limit there is a very small proportion of gasoline vapor, indicating the great importance of not allowing even a little gasoline to be exposed in a room or confined space.

Tractor fuel, sold for farm use in many places, generally has fire and explosion hazards similar to gasoline. It should be treated as gasoline, except in cases where it is definitely known to be similar to kerosene in fire-hazard properties.

Kerosene (lamp oil, coal oil, range oil) is not highly flammable, but it will give off explosive vapors when heated to above its "flash point," which is usually a little above 100° F. Gasoline has a flash point of 0° F. or lower, which means that it will give off explosive vapors at any ordinary temperature. Flash point should not be confused with ignition temperature; explosive vapors are produced whenever a liquid is exposed to the air at a temperature above its flash point, but these vapors do not burn or explode unless there is some flame or spark to ignite them.

Flammable liquids may produce dangerous vapors when discharged in a fine spray, even when the temperature is lower than the flash point.

DANGER OF STARTING AND REVIVING FIRES WITH GASOLINE OR KEROSENE

With considerable regularity the press contains news items of lives and property destroyed as a result of an attempt to start or revive a fire in a stove or a furnace with flammable liquids, generally kerosene (fig. 1). The lives lost and farm homes destroyed as a result of this practice are in some cases due to the use of gasoline mistaken for kerosene but more generally to the pouring of kerosene into a firebox that is still warm from a previous fire. In that case the kerosene is heated to above its flash point and produces explosive vapors similar to those from gasoline. The greatest danger is where the kerosene is not immediately ignited but is heated by hot ashes and forms explosive vapors to mix with air. The danger is minimized if kerosene is not poured into a stove, but a corncob (or some similar object) that has been soaked in kerosene is lighted as it is put into the stove to kindle the fire.

FIGURE 1.—Never pour kerosene or gasoline on a fire.

THE SAFE WAY TO HANDLE OIL LAMPS, HEATERS, STOVES, INCUBATORS, BROODERS, AND LANTERNS

Kerosene lamps, heaters, stoves, incubators, brooders, and lanterns should be carefully handled. They should never be filled while burning. In extinguishing lighted lamps, lanterns, and heaters turn down the wick a little and put out the flame by blowing over the top of the burner. It is dangerous to blow out the flame from underneath or to turn the wick down very low.

Wicks and burners should be kept clean. Boil the burners occasionally in soda, lye, or soap. An explosion may result from defective wicks that do not entirely fill the wick-tube section of the burner. Such wicks permit free communication between the flame and the space above the oil in the reservoir.

Kerosene stoves should be provided with a drip pan under the burners.[4]

Kerosene lamps should be of substantial construction with broad bases so that they will not be readily overturned. Lamp shades

[4] Standards for Small Heating and Cooking Appliances, as published by the National Fire Protection Association in the National Fire Codes for Flammable Liquids, Gases, Chemicals, and Explosives; and also by the National Board of Fire Underwriters as Pamphlet No. 310.

should be of material that will not burn. Never place lamps near the edge of a table or near curtains.

Lanterns should be free from leaks, and lighted lanterns when not being carried should be hung on substantial hooks or supports out of the wind, away from cobwebs and other combustible materials, and at a height sufficient to insure protection against damage or disturbance.

Do not place kerosene lamps or lanterns above stoves or in other warm places. The heating of the kerosene in the receptacle forms vapors that cause "flaring."

Do not carry lighted oil heaters or portable stoves about the house. Keep them at a safe distance from combustible material. The heaters should be so placed that they are not likely to be hit by swinging doors or by children in their play.

Brooders should be placed in an isolated location. It is dangerous to operate them in a house or barn. Overheating should be guarded against.

Although the fire hazard from incubators is not considered so great as that from brooders, they should be operated with care, especially when in the home. Guard against overheating. Use brooders and incubators that are listed by Underwriters' Laboratories, Inc.

HAZARDS IN USING PETROLEUM PRODUCTS AND EQUIPMENT

DRY CLEANING

Naphtha, gasoline, and benzine are too highly flammable for use in dry cleaning. During cleaning operations vapors are given off that are most likely to form explosive mixtures with the air. Any spark or open flame may ignite the mixture of flammable vapors and air and cause disastrous explosions. Ignition sources may be open flames of any kind, stoves, electric sparks from operating an electric switch, or any one of numerous potential fire causes around the home. Sometimes ignition may even occur from sparks of static electricity caused merely by friction of garments or by an act of pouring the liquid from one container to another.

FIGURE 2.—Use a nonflammable liquid such as carbon tetrachloride for dry cleaning at home.

Where dry cleaning must be done at home, the use of such nonflammable cleaners as carbon tetrachloride is recommended (fig. 2). It should be remembered, however, that carbon tetrachloride and most other dry-cleaning solvents produce vapors that may be dangerous to breathe in any quantity. Therefore, any dry-cleaning operation should be done in a well-ventilated room or preferably out of doors, and the quantity of liquid used should be kept at the minimum.

There are many dry-cleaning solvents sold under a variety of trade names having cleaning properties similar to gasoline but fire-hazard properties similar to kerosene. Such liquids are far safer than gasoline

for dry cleaning but should be used with proper care. It is much better to do the cleaning with such liquids out of doors and to hang up freshly cleaned garments to dry out of doors rather than in a warm room where the flammable fumes from the liquids may accumulate.

SPRAYING INSECTICIDES

Spraying insecticides in the home for the purpose of killing flies, moths, and ants is now a common practice. Most of these liquids, if not all of them, are flammable. Spraying, therefore, should not be done in the presence of an open flame or a lighted cigar, cigarette, or pipe, or other source of ignition, and the container holding the liquid should be kept closed and away from heat. It is a good practice to disconnect any electrical equipment that might cause sparks before starting the spraying.

PAINTS AND LACQUERS

Some of the modern quick-drying paints and lacquers dry by the evaporation of some volatile solvent with fire-hazard properties similar to gasoline. These paints and other finishes should therefore be used only in well-ventilated rooms, and such sources of ignition as open flames, cigarettes, and lanterns should be kept away from the vicinity of the painting operation. The danger depends largely upon the surface covered; repainting a small object, as a chair, produces fewer fumes than when an entire wall surface is coated.

The danger of the production of flammable vapors may be roughly estimated by the speed with which the solvents will evaporate and the paint dry up when left in an open can. There may be some exceptions, however, for some relatively quick-drying paints do not produce flammable vapors in large quantities. Most paints contain linseed or other drying oils that have a tendency to heat spontaneously when soaked up in rags or cotton waste. Paint rags should be burned or placed in a covered metal can immediately.

When painting in cold weather, never place the can of paint on top of the stove to heat. Many lives have been lost as a result of this practice. If it is necessary to heat paint before applying it, place the paint can in a pan of hot water away from the stove.

Paint removers, except those mixed with water, give off highly flammable vapors and should be used only in well-ventilated locations where there is no possible source of ignition.

GASOLINE STOVES, LAMPS, AND TORCHES

The use of gasoline as fuel for any domestic purpose is more hazardous from the point of view of fire and explosion than any ordinary fuel, as wood, coal, or gas. The use of gasoline stoves, lamps, or torches involves the handling of gasoline in or around buildings, and the possibility of some accident resulting in the spilling of gasoline is an ever-present hazard. Even with the best of equipment, carefully maintained and operated, it is not wholly safe to use gasoline-burning equipment in the home.[5]

[5] Standards for the proper design, operation, and maintenance of gasoline-burning appliances of various types will be found in the National Fire Codes for Flammable Liquids, Gases, Chemicals, and Explosives, published by the National Fire Protection Association; and standards for gasoline vapor lamps and systems in the National Board of Fire Underwriters' Pamphlet No. 53.

Where gasoline stoves are used, they should be of types tested and listed by Underwriters' Laboratories, Inc. Stoves should not have in the building a gasoline reservoir of more than 1-gallon capacity. If a larger quantity is required, the container should be outside the building with the fuel brought to the stove through a tube. Tanks of gasoline stoves should be filled with great care and only when there is no open flame, sparking device, lighted cigarette or pipe, or other possible source of ignition in the vicinity.

Gasoline lamps and lanterns, like gasoline stoves, involve an increased fire hazard, owing to the necessity of handling gasoline, although the lamp or lantern may be carefully maintained and operated. Gasoline lamps and lanterns should always be kept clean, excessive pressure should be avoided, and the lamp or lantern should be removed from the building immediately upon any sign of leakage or improper operation.

Gasoline blowtorches should be of safe types and should also be handled carefully and filled only at safe places, preferably outdoors. When the torch is started, the priming cup should not be overfilled, as the gasoline may flow over the tank and become ignited, thus furnishing sufficient heat to develop dangerous pressure in the tank. If gasoline should flow over the tank, it should be carefully wiped off before the torch is lighted. Torches should be carefully operated and used and should be removed from the building if there is any sign of leakage or improper operation. Burning torches should never be left unattended.

Only unleaded gasoline should be used in any gasoline-burning device.

AUTOMOBILES, TRUCKS, TRACTORS, AND STATIONARY ENGINES

Stationary and automotive engines may backfire when started. If this happens in the vicinity of combustible materials or explosive gases and dusts, a fire may result. Combustible materials should be kept away from such equipment even when in apparently normal operation, because there is always the chance that a fire may be caused by an overheated or faulty muffler, hot or burning carbon deposits, and faulty ignition. It is dangerous, therefore, to house or use gasoline and kerosene engines, automobiles, motortrucks, and tractors in barns and granaries.

Do not start automobile or other gasoline engines in a closed garage or other building. (This precaution does not apply to engines equipped with a fixed exhaust to the outside of the building.) In starting such engines it frequently happens that the mixture is too rich. As a consequence, deadly carbon monoxide (CO) is given off. This gas in very small quantities is fatal to human life. Furthermore, the fact that it is odorless and colorless and cannot be detected either by the sense of smell or of sight makes it doubly dangerous. Before starting engines in confined spaces always open doors and windows in order to provide ventilation and permit the escape of carbon monoxide.

Cleaning automobiles, tractors, and stationary engines with gasoline is dangerous. The vapor produced presents an explosion hazard, the source of ignition readily being supplied by an open flame, a lighted cigar or cigarette, static electricity, the ignition system of the engine, or a spark caused by striking two pieces of metal together.

POURING GASOLINE FROM ONE CONTAINER INTO ANOTHER

Dangerous vapors are given off when gasoline is poured from one container into another or when the liquid is exposed to the air, thus forming an explosive mixture of vapor and air that may be ignited very easily. Consequently such pouring should not be done near open flames or lights, or near engines and motors while they are running. Smoking and electric and metallic sparks also are sources of ignition that should be guarded against.

Another source of ignition is static electricity. Static electricity can be generated through the use of gasoline in several ways; for example, by pouring it from a pipe, a hose, or container into another container without having a metallic connection between the two containers. It could likewise be produced when gasoline is filtered through chamois. The use of chamois should therefore be avoided. The generation of static electricity through failure to observe these precautions may result in an electric spark that can ignite the vapor in the immediate vicinity.

In pouring gasoline from a can or a drum into another container with a funnel, for example, a simple expedient is to keep the mouth of the container from which the gasoline is being poured in contact with the funnel, and the funnel in turn in direct contact with the receptacle being filled. When filling the tank of the tractor, automobile, or gas engine it is a simple matter to keep the metal nozzle of the hose in contact with the mouth of the tank, thus preventing the passage of a static spark.

FUEL-OIL BURNERS

Although on farms the use of oil for heating the home is limited, the subject is of sufficient importance to be touched upon in this bulletin.[6]

As with heating apparatus of other kinds a fire hazard is associated with domestic oil burners. It is of great importance, therefore, that only domestic oil burners be selected or used that have been tested by and bear the label of the Underwriters' Laboratories, Inc. This label is assurance to the buyer or user that the oil burner bearing the label has been safeguarded to a reasonable degree and is so made that it may readily be installed in accordance with the recommendations of the National Fire Protection Association.

Oil-burning systems involve the installation of tanks, piping, the burner proper, and, in most cases, electrical wiring. In handling all this equipment, the recommendations of the National Fire Protection Association[7] and the National Electrical Code should be followed. The installation should be made only by competent, reliable workmen, strict attention being paid to the manufacturer's instructions. The principal object to keep in mind when installing tanks and piping for an oil burner is the delivery of the oil to the burner without any leakage.

The equipment, once installed, should receive adequate and intelligent attention. Inexperienced persons should not tamper with automatic devices controlling the operation of the burner.

[6] For further information see U. S. Dept. Agr. Cir. 406, Oil Burners for Home Heating. Out of print, but may be consulted in libraries.

[7] Standards for the Installation of Oil Burning Equipments, as published by the National Fire Protection Association in the National Fire Codes for Flammable Liquids, Gases, Chemicals, and Explosives; and also by the National Board of Fire Underwriters in Pamphlet No. 31.

Oils used in domestic oil burners should have a flash point of not less than 100° F. or the local legal minimum.

Range oil burners should be substantially constructed. The fuel container should be well supported, not too close to the stove, and so located as not to be accidentally hit or damaged. Manufacturer's directions should be rigidly followed in installing these devices.[8] The largest number of fires in connection with range oil burners are caused by placing the stand for the oil bottle too high, so that the oil flows into the stove faster than it should. Another frequent cause of fire, sometimes having fatal results, is the spilling of kerosene or range oil over the outside of the bottle when it is being filled, making the surface slippery. The bottle may then be dropped as it is being carried into the kitchen, and if it falls on or near the stove it is very liable to ignite.

PROPER STORAGE OF GASOLINE AND KEROSENE [9]

It is very important that the farmer who uses gasoline and kerosene on his farm give serious consideration to their storage.

GASOLINE

The best method of storing gasoline is in an underground tank having a gasoline pump similar to the equipment used in filling stations. The pump should be located well away from buildings, and all tractors and other equipment having tanks that require filling should be brought to the pump. Gasoline tanks should be buried underground, with the top not less than 2 feet below the surface of the ground and below the level of any connected piping. Tanks should not be buried under any roadways where heavy trucks or tractors may pass, unless a reinforced concrete slab is provided to protect the tank. Tanks, pumps, and other equipment should be of approved types and installed in accordance with recognized standards.

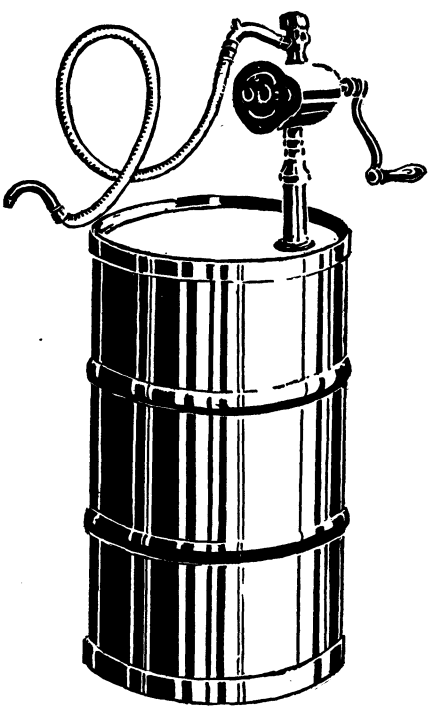

FIGURE 3.—Pump and steel drum for storing gasoline.

The next best method of handling gasoline is in a substantially constructed steel drum (fig. 3) kept well away from all buildings, with the gasoline drawn from the drum by a pump. A roof and an enclosure may be placed around the drum to provide protection from the weather and to prevent tampering, but the drum should not be

[8] Suggested Ordinance Regulating Range Oil Burners, as published by the National Fire Protection Association in the National Fire Codes for Flammable Liquids, Gases, Chemicals, and Explosives.

[9] For details on the placing, construction, and venting of tanks and on pumps and piping, see Suggested Ordinance Regulating the Use, Handling, Storage, and Sale of Flammable Liquids and the Products Thereof, 1938 Edition, published by the National Fire Protection Association in the National Fire Codes for Flammable Liquids, Gases, Chemicals, and Explosives.

placed in any tight building where the explosive fumes of gasoline may accumulate in case of a leak or a spill.

If it is necessary to carry gasoline into buildings, containers of not more than 1-gallon capacity should be used. Safety cans of approved types are available for this purpose (fig. 4).

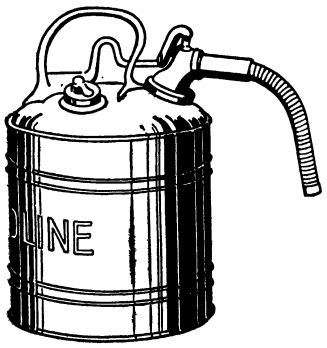

FIGURE 4.—Safety can for storing small quantities of gasoline.

KEROSENE

Kerosene should not be stored or handled in open containers in any building.

Only moderate quantities of kerosene should be stored in buildings, and then only in closed containers or substantial drums equipped with a pump. The containers should be kept at a safe distance from furnaces or other heating appliances and from flammable rubbish. Kerosene for immediate use should be kept in a can that is distinctly painted and that is entirely different in size and shape from the container in which gasoline is stored. This will greatly lessen the possibility of gasoline being used by mistake, especially at night.

Large quantities of kerosene should be stored outside buildings in substantial drums equipped with a pump or in an underground tank also so equipped.

It is important that cans, barrels, and drums holding kerosene be kept clean and that the word KEROSENE be painted on them in a conspicuous manner.

DRAWING GASOLINE AND KEROSENE

Gasoline and kerosene should never be drawn or handled in the presence of open flames or fire. If it is necessary to draw them at night, light should be afforded by electric flashlight or incandescent electric lamps installed in compliance with the National Electrical Code.

Drums for gasoline and kerosene should be provided with caps, plugs, or bungs, and these should always be replaced immediately after the liquid has been drawn from the container.

Smoking or the use of matches should not be permitted where vapors of flammable liquids are present or are likely to be formed.

HOW TO EXTINGUISH GASOLINE AND KEROSENE FIRES[10]

Fires are commonly put out in two ways: (1) By cooling the burning materials to below their burning temperature; and (2) by smothering the fire and thus depriving it of the air (oxygen) necessary to support combustion.

Gasoline and kerosene fires are best extinguished by smothering, as by a foam or fire-extinguishing gas. The following appliances are recommended for fighting such fires: Foam extinguishers, carbon dioxide extinguishers, vaporizing-liquid extinguishers (carbon tetra-

[10] Much of the material on this subject is based on the Standards for the Installation, Maintenance and Use of First Aid Fire Appliances, published by the National Fire Protection Association in the National Fire Codes for Extinguishing and Alarm Equipment (Pt. 2); and also by the National Board of Fire Underwriters in Pamphlet No. 10.

chloride base), loaded-stream extinguishers, and extinguishers delivering a dry chemical propelled by compressed gas.

It is important that only first-aid fire appliances that have been listed by and bear the label of Underwriters' Laboratories, Inc., or the

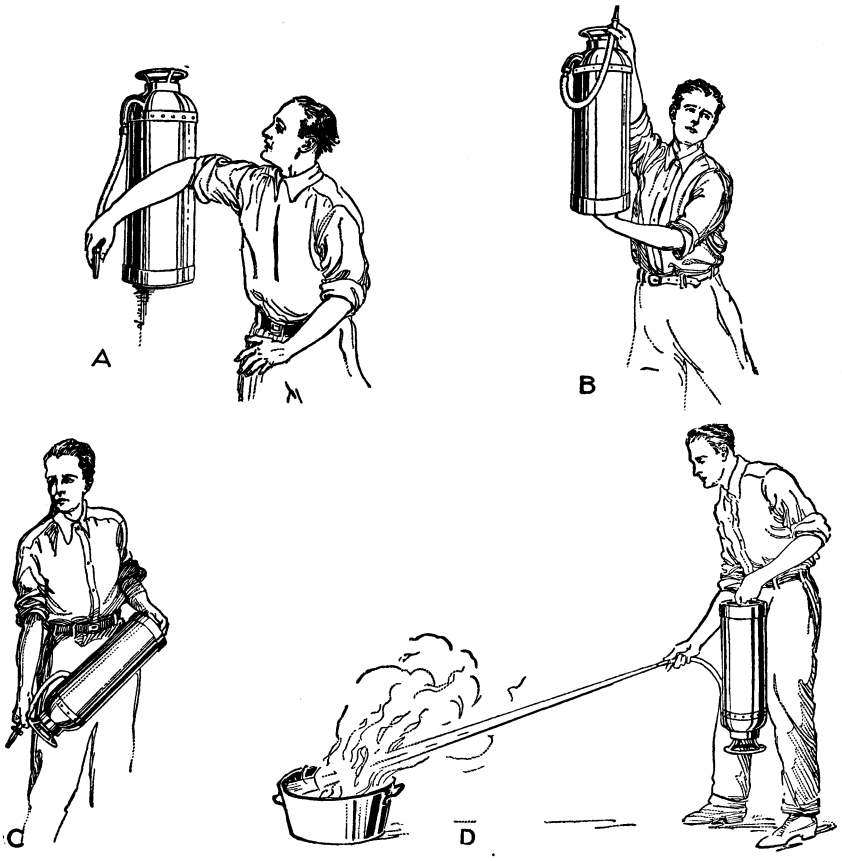

FIGURE 5.—Foam type of extinguisher. *A*, It is important that the hose be held between the thumb and the index finger of the right hand when bringing the extinguisher into use. *B*, Grasp the ring top with the fingers of the right hand and the bottom with the left hand; then lift the extinguisher off the hanger hook and carry it to the fire. *C*, The extinguisher can now be easily inverted by grasping the bottom handle with the left hand. When the extinguisher is approximately in the position shown, the fingers of the right hand should release the ring top, but should continue to hold the hose. The extinguisher, upside down, the left hand holding the bottom handle, is now in full operation. *D*, The stream should be directed against the inside of the opposite wall of the tank, above the level of the burning liquid. The operator should walk around the fire if possible, and if the fire is on the floor he should stand back and allow the foam to fall on the fire without much force, thereby preventing the spread of the flames.

Factory Mutual Laboratories, or other recognized testing laboratory be selected or used and that the appliances be properly operated and maintained.

Because the effective period of discharge of some extinguishers is comparatively short, ranging from 15 to 205 seconds, the operator

should be sure that he knows the location of the seat of the fire and that he is sufficiently close before putting the extinguisher into operation; otherwise the maximum effectiveness of the device will not be obtained.

In using extinguishers of the carbon dioxide and vaporing-liquid types, especially in unventilated places, such as small rooms, closets, or confined spaces, operators and others should guard against breathing the vapors or gases liberated or produced.

As a guide in determining the number and size of extinguishers needed, it is considered that one of the following units would provide protection against a flammable-liquid fire which would be apt to occur on the farm. (1) Two 1½-gallon or one 2½-gallon foam extinguisher; (2) four 2-pound, two 4-, 7½-, or 10-pound, or one 15-pound carbon dioxide extinguisher; (3) two 1-, 1¼-, 1½-, or 2-quart vaporizing-liquid extinguishers; (4) two 1¾- or 2½-gallon loaded-stream extinguishers; (5) one 15- or 20-pound extinguisher delivering dry chemical propelled by compressed gas.

FOAM EXTINGUISHERS

Most hand extinguishers of the foam type (fig. 5) come in two sizes, 1½- and 2½-gallon.

When an extinguisher of this type is inverted, the two solutions contained in it mix and react, producing a foam under sufficient pressure to furnish a forceful stream. One solution is sodium bicarbonate and a foam-producing agent, and the other is a water solution of aluminum sulfate. About 20 gallons of foam are produced by the 2½-gallon extinguisher.

The foam extinguishes a fire by both the cooling and smothering effects. Containing a liberal quantity of water, it has considerable cooling effect. The foam itself smothers the fire by clinging to the burning materials and excluding air (oyxgen). This extinguisher is effective on fires in small quantities of flammable liquids in open vessels or on floors, where the foam may be retained as a blanket on the burning material.

Although the stream is usually most effective when directed from a distance, it may also be used close to the fire. In case of necessity it can be directed effectively from a distance as great as 30 to 40 feet. The foam extinguisher must be protected against freezing.

CARBON DIOXIDE EXTINGUISHERS

The carbon dioxide type of extinguisher (fig. 6) commonly comes in cylinders containing 2, 4, 7½, 10, or 15 pounds of carbon dioxide, liquefied under pressure.

Two-thirds to three-fourths of the gas content in the cylinder is liquefied by pressure. Because of rapid expansion and high heat capacity, a part of this gas, when released, instantly freezes into a dry carbonic snow, which is intensely cold (−110° F.). It does not melt, but evaporates directly into a gas. The fire is extinguished mainly by the blanketing effect of the carbonic gas. The carbon dioxide is a nonconductor of electricity.

This type of extinguisher is effective on fires in small quantities of flammable liquids in open vessels or on floors, where the blanketing

effect of the extinguishing gas is of value. It has a maximum range of about 8 feet, but best results are obtained by directing the discharge

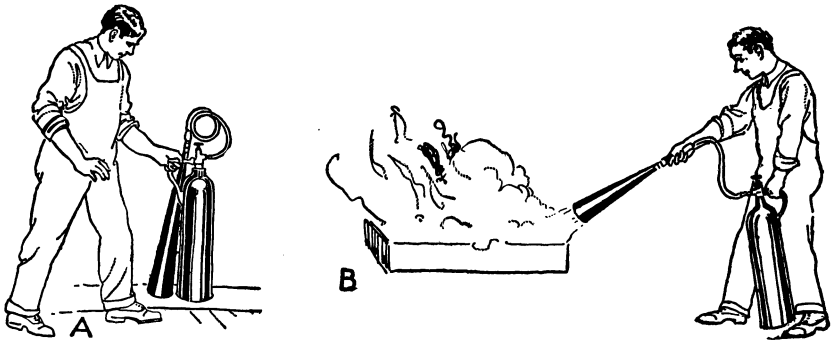

FIGURE 6.—Carbon dioxide type of extinguisher. *A*, The extinguisher is removed by grasping the handle with the left hand. It should be carried to the fire by means of the handle. To release the gas the valve is opened by turning it counterclockwise. *B*, Direct the discharge as close to the fire as possible, applying it first at the edge and bottom of the fire and progressing forward and upward, moving the discharge horn slowly from side to side. Continue the discharge even after the fire has been extinguished in order to cool the liquid and prevent possible reflashing.

as close to the fire as possible. This extinguisher does not need protection against freezing.

VAPORIZING-LIQUID EXTINGUISHERS (CARBON TETRACHLORIDE BASE)

The most common sizes of the vaporizing-liquid type of extinguisher (fig. 7) are those of 1-, 1¼-, 1½-, and 2-quart capacity. By means of a

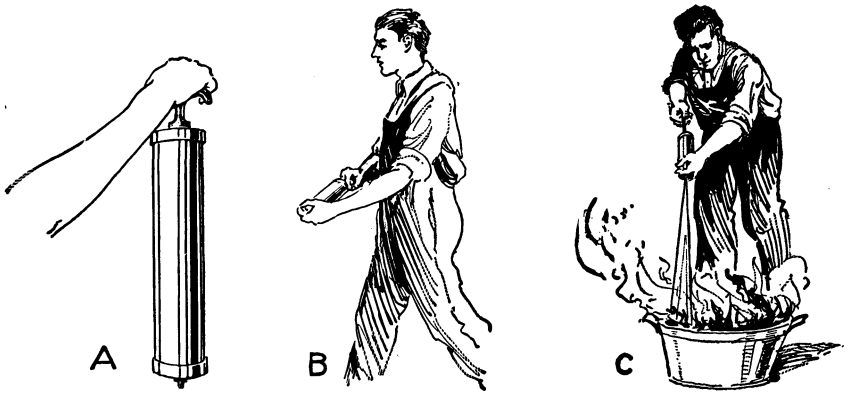

FIGURE 7.—Vaporizing-liquid type of extinguisher. *A*, Remove the extinguisher from the wall bracket by grasping the handle and pulling outward. *B*, On the way to the fire unlock the handle by turning. If the device is of the air-pump type, hold a finger over the nozzle and pump up the pressure. *C*, Direct the stream at the base of the flames and work around the fire rapidly. If the fire is in an open container or tank, direct the stream against the inside of the opposite wall above the level of the burning liquid.

hand pump, a stream of liquid having a carbon tetrachloride base is expelled on the fire. The heat of the fire causes this liquid to vaporize, producing an incombustible, heavier-than-air gas that forms a

blanket over the burning material, cutting off the supply of air (oxygen) necessary to support combustion. This liquid is a nonconductor of electricity. In using extinguishers of this type, especially in such unventilated spaces as small rooms, closets, or confined spaces, operators and others should take precautions to avoid the effects that may be caused by breathing the vapors or gases liberated or produced. This type of extinguisher needs no protection against freezing.

The vaporizing-liquid type of extinguisher is effective on fires in small quantities of flammable liquids in open vessels or on floors, where the gas formed by the heating of the extinguishing liquid may be retained as a blanket on the burning material. Although the stream is usually most effective when used close to the fire, in case of necessity it can be directed from a distance of 20 feet.

LOADED-STREAM EXTINGUISHERS

The loaded-stream extinguisher is made principally in two sizes, 1¾- and 2½-gallon. It is effective on fires in small quantities of flammable liquids in open vessels or on floors. The chemical used is a special antifreeze solution containing certain alkali metal salts. These extinguishers are supplied in two forms. One employs a small carbon dioxide cartridge for expelling the chemical solution; the other uses a special acid contained in a sealed bottle.

This type of extinguisher is operated by inverting it (see fig. 5) and then bumping it on the floor. When the extinguisher is inverted and bumped, the pressure produced or released expels the contents through the hose. Although the stream is most effective when used close to the fire, when necessary it can be directed effectively from a distance of 30 to 40 feet. This type of extinguisher needs no protection against freezing.

DRY-CHEMICAL EXTINGUISHERS (STORED-PRESSURE-OPERATED)

The 15- and 20-pound sizes of extinguisher delivering dry chemicals propelled by compressed gas are suitable for farm use. The dry chemical used gives off carbon dioxide when in contact with the fire, and the combined action of this and the propelling gas is similar to that of the carbon dioxide type of extinguisher.

USE OF SAND, SODA AND SAWDUST, AND WATER

Sand is useful in preventing fires by covering or absorbing spilled flammable liquids. It may also be used in putting out small, isolated fires in flammable liquids on floors.

Sawdust evenly mixed with sodium bicarbonate, in the proportion of 10 pounds of soda to 1 bushel of sawdust, is effective on small fires of lubricating oils and greases in open vessels or on floors when the mixture is applied rapidly and is spread over the entire surface.

Water has not ordinarily been considered effective in fighting fires in flammable liquids, and this is true as regards the use of ordinary hose streams, water thrown from buckets, and similar measures. Under some conditions, however, water may be very useful in fighting fires in flammable liquids. A fine spray of water under pressure, such as that produced by a tree sprayer, can often be used effectively

in controlling flammable-liquid fires. Water can also be used to advantage to keep tanks and other containers cool in case there is fire around them and explosions are feared. In some cases where it is not possible to extinguish a gasoline fire, a spray of water may be used to absorb the heat and keep the surroundings cool while the gasoline is burning itself out.

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